AMENDMENTS TO THE CLAIMS

I claim:

1. (currently amended) A Method method for dynamically optimize optimizing data throughput at the radio interfaces of a packet data cellular network, said interfaces comprising having at disposal of said interfaces one or more types of modulations having different immunity from transmission errors when used for transmitting bursts of data, said data being packed-up in blocks, between mobile stations (MS) and the serving base station (BTS), and vice versa, comprising the steps of:

-        obtaining for each available modulation at least one of an upgrade and/or a downgrade tabulated threshold of the Block Error Rate, or BLER, delimiting a range in which that the available modulation outperforms the other available modulations in terms of net data throughput;

-        averaging and comparing the BLER Block Error Rate, substantially continuously, on of the relevant temporary connection being continuously averaged and compared with the tabulated thresholds for selecting the proper modulation; characterized in that includes the steps of:

-        combining each available modulation with two or more coding schemes thereby obtaining as many modulation-and-coding schemes, termed hereinafter MCSs, with different protection against transmission errors;

−   obtaining for each MCS modulation and coding scheme at least one of a first upgrade and/or a first downgrade tabulated BLER Block Error Rate threshold which is (A) valid for low-diversity RF radio frequency channels, delimiting a range in which the modulation and coding scheme that MCS outperforms the other available modulation and coding schemes in terms of net data throughput, and considering as low-diversity a channel without frequency hopping and with low user mobility;

−   obtaining for each modulation and coding schemeMCS at least one of a second upgrade and/or a second downgrade tabulated BLER Block Error Rate threshold (B)which is valid for high-diversity RF radio frequency channels, delimiting a range in which that MCSthe modulation and coding scheme outperforms the other available modulation and coding schemes in terms of net data throughput, and considering as high-diversity a channel characterized by frequency hopping or high user mobility;

−   selecting either the first (A) or the second (B) tabulated thresholds according to the diversity of the RF radio frequency channel which sustains the a temporary connection: and

–   use using the selected thresholds for discriminating the a right modulation and coding schemeMCS.

2. (Currently Amended) The Method method for dynamically optimizing data throughput according to claim 1, characterized in that wherein the step of discriminating the a right modulation and coding schemeMCS is performed byfurther comprises the steps of:

–   updating, at each new incoming block of data, an averaged value of BLER Block Error Rate evaluated in correspondence of the an actual modulation and coding schemeMCS;

–   comparing said the averaged BLER Block Error Rate with the at least one of the upgrade and/or downgrade thresholds of the actual modulation and coding schemeMCS;

–   replacing the actual modulation and coding schemeMCS with the MCSa modulation and coding scheme immediately less error protected when the averaged BLER Block and Error Rate is lower than said the upgrade threshold; or

–   replacing the actual modulation and coding schemeMCS with the modulation and coding schemeMCS immediately more error protected when the averaged BLER Block and Error Rate is higher than said the downgrade threshold.

3. (Currently Amended) The Method method for dynamically optimizing data throughput according to claim 1, characterized in that includes further comprising the steps of:

–   obtaining for each modulation and coding schemeMCS at least one of a third upgrade and/or third downgrade tabulated BLER Block Error Rate thresholds (C) valid for both low-diversity channels and incremental redundancy active, and

–   delimiting a range in which that MCSthe modulation and coding scheme outperforms the other available modulation and coding schemeMCSs in terms of net data throughput.

4. (Currently Amended) The Method method for dynamically optimizing data throughput according to claim 1, characterized in that includes further comprising the steps of:

- -obtaining for each <u>modulation and coding scheme</u>MCS <u>at least one of a</u> fourth upgrade and/or downgrade tabulated BLER <u>Block Error Rate</u> thresholds (D) valid for both high-diversity channels and incremental redundancy active,<u>, and</u>

- delimiting a range in which that MCS<u>the modulation and coding scheme</u> outperforms the other available <u>modulation and coding scheme</u>MCSs in term of net data throughput.

5. (Currently Amended) The Method <u>method</u> for dynamically optimizing data throughput according to claim 3, characterized in that <u>wherein</u> the <u>a</u> receiving entity carries out <u>performs</u> the steps of:

— temporarily storing errored data blocks in a memory buffer for joint decoding them <u>with</u> new transmissions of original blocks according to the <u>an</u> incremental redundancy technique;<u> and</u>

— continuously checking a condition of buffer full and other causes making retransmission with incremental redundancy inapplicable, for building a status variable, named hereinafter IR_status, <u>which</u> measures the <u>an</u> averaged status of the incremental redundancy.

6. (Currently Amended) The Method <u>method</u> for dynamically optimizing data throughput according to the preceding claim when it depends on claim 3<u>5</u>, characterized in that<u>wherein</u> for each <u>modulation and coding scheme</u>MCS a linear interpolation is performed run-time between <u>at least one of the</u> first (A) and third (C) upgrade threshold<u>s</u> and/or between <u>the</u> first (A) and third (C) downgrade threshold<u>s</u>, using the IR_status<u>status variable</u> as interpolating factor for unbalancing the entity of the interpolation either towards third thresholds (C) when incremental redundancy prevails, or towards first thresholds (A) or <u>in a</u> the contrary case.

7. (Currently Amended) The Method <u>method</u> for dynamically optimizing data throughput according to claim 5, characterized in that<u>wherein</u> for each <u>modulation and coding scheme</u>MCS a linear interpolation is performed run-time between <u>at least one of the</u> second (B) and fourth (D) upgrade threshold<u>s</u> and/or between <u>the</u> second (B) and fourth (D) downgrade threshold<u>s</u>, using the IR_status<u>status variable</u> as interpolating factor for unbalancing the entity of the interpolation either towards fourth thresholds (D) when incremental redundancy prevails, or towards second thresholds (B) or <u>in</u> the contrary case.

8. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 5, ~~characterized in that~~ wherein the averaged status of the incremental redundancy is obtained by:

- ~~-~~ -weighting both ~~the~~ a preceding and ~~the~~ an actual values of a variable, ~~named hereinafter IR_check~~,

- ~~-~~ taking value 1 if incremental redundancy is properly working, ~~or~~ and value 0 ~~for~~ on the contrary, and

- ~~-~~ using a digital filter having a pulse response exponentially decreasing with discrete time n spanning a data block period.

9. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 1, ~~preceding claims, characterized in that~~ wherein said the averaged value of ~~BLER~~ Block Error Rate is obtained by weighting both ~~the~~ preceding values of ~~BLER~~ Block Error Rate and ~~the~~ actual decisions on errored blocks, using a digital filter having a pulse response exponentially decreasing with discrete time n spanning a block period.

10. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 9, ~~characterized in that~~ wherein the pulse response of ~~said~~ the digital filter of ~~BLER~~ Block Error Rate is obtained by summing ~~up~~ two weight functions both accepting samples with ~~the~~ a commanded modulation and coding scheme~~MCS~~, a first one to weigh the preceding values of ~~BLER~~ Block Error Rate and the second one to weigh the actual decisions on errored blocks.

11. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 10, ~~characterized in that~~ wherein ~~said~~ the first and second weight functions have balanced weights, so that an arbitrary increasing of ~~the~~ a weight of the first function also involves an equal decreasing of the weight of the second function, and vice versa.

12. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 11, ~~characterized in that~~ wherein the weight of ~~said~~ the first and second weight functions are both equally varied in order to compensate ~~the~~ a missing filtering effect of possible lacking blocks, in that making ~~the~~ an outlined pulse response possible.

13. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 12, ~~characterized in that the variation of said~~wherein the first and second weights are carried out by making the ~~said~~ first and second weight functions further depending on a reliability function which tracks ~~the~~ an age of the received blocks.

14. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 10, ~~characterized in that said~~wherein the temporary connection is dedicated to transfer packet data from a selected mobile station to the base station, and ~~said~~ the pulse response of ~~BLER~~ Block Error Rate digital filter is obtained ~~by means of the following function~~according to the function:

$$BLER_n = f_1(BLER_{n-1}) + f_2(s_n)$$

where~~in~~:

- n is ~~the~~ an iteration index spanning one block period;
- $s_n = 0$ if ~~the~~ a block at instant n has been correctly received;
- $s_n = 1$ if ~~the~~ a block at instant n has not been correctly received;
- $s_n = \frac{1}{K}\sum_{k=1}^{K} s_{n,k}$ if K blocks are received for ~~the~~ a considered connection;
- $f_1(BLER_{n-1})$ is ~~said~~ the first weight function, taking values inside ~~the~~ an interval 0 - 1; and
- $f_2(s_n)$ is ~~said~~ the second weight function of the variable s_n relative to ~~the~~ a decision on the errored blocks, taking values inside the interval 0 — 1.~~;~~

15. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to ~~the preceding~~ claim 14, ~~characterized in that said~~wherein the first and second weight functions ~~assume~~ comprise the following expressions:

$$f_1(BLER_{n-1}) = (1 - \beta \cdot \frac{x_n}{R_n}) \cdot BLER_{n-1}$$

$$f_2(s_n) = \beta \cdot \frac{x_n}{R_n} \cdot s_n$$

where~~in~~:

- x_n is equal to 1 if "at least" one RLC block for ~~the~~ a considered connection with ~~the~~ a commanded MCS is received at time instant n, otherwise is set to 0;

- $\beta = 1/T_{AVG}$ is a forgetting factor and T_{AVG} being ~~the~~ a filtering period in multiples of a radio block; and

- $R_n = (1-\beta) \cdot R_{n-1} + \beta \cdot x_n; \; R_{-1} = 0$ is said reliability function.

16. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 8, ~~characterized in that said~~ wherein the temporary connection is dedicated to transfer packet data from a selected mobile station to the base station, and said pulse response of the digital filter of the ~~IR_status~~ status variable is obtained ~~by means of~~ according to the following function:

$$IR\_status_n = f_1(IR\_status_{n-1}) + f_2(IR\_check_n)$$

wherein:

- n is ~~the~~ an iteration index spanning one block period; and

- f_1 and f_2 are weight functions ~~following the~~ according to same laws as used in the Block Error Rate ~~BLER~~ calculation.

17. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 16, ~~characterized in that said~~ wherein the first and second weight functions ~~assume~~ comprise the following expressions:

$$f_1(IR\_status_{n-1}) = (1 - \beta \cdot \frac{x_n}{R_n}) \cdot IR\_status_{n-1}$$

$$f_2(IR\_check_n) = \beta \cdot \frac{x_n}{R_n} \cdot IR\_check_n$$

wherein: R_n takes a formal expression as that used in the ~~BLER~~ Block Error Rate calculation, while x_n and β are the same.

18. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 6, ~~characterized in that~~ wherein ~~said~~ the linear interpolations ~~take~~ comprise the following expressions:

$$UP\_th_n = (1 - IR\_status_n) \times BLER_{MCSx \to MCSy} + IR\_status_n \times BLER_{MCSx\_wIR \to MCSy\_wIR}$$

$$DN\_th_n = (1 - IR\_status_n) \times BLER_{MCSx \to MCSz} + IR\_status_n \times BLER_{MCSx\_wIR \to MCSz\_wIR}$$

wherein:

- UP_th_n and DN_th_n are ~~the~~ an upgrade and downgrade thresholds, respectively, at ~~the~~ an n-th block period;

- $BLER_{MCSx \to MCSy}$ is an upgrade first (A) or second (B) tabulated threshold;

- $BLER_{MCSx\_wIR \to MCSy\_wIR}$ is an upgrade third (C) or fourth (D) tabulated threshold;

- $BLER_{MCSx \rightarrow MCSz}$ is a downgrade first (A) or second (B) tabulated threshold;

- $BLER_{MCSx\_wIR \rightarrow MCSz\_wIR}$ is a downgrade third (C) or fourth (D) tabulated threshold.

19. (Currently Amended) ~~Method~~ The method ~~for dynamically optimizing data throughput~~ according to claim 10, ~~characterized in that~~wherein ~~said~~the temporary connection is dedicated to transfer packet data from the base station to a selected mobile station, and ~~said~~the pulse response of ~~BLER~~Block Error Rate digital filter is obtained ~~by means of~~according to the following function:

$$BLER_k = f_1(BLER_{k-1}) + f_2(s_k)$$

where~~in~~:

- k is ~~the~~a reporting instant lasting m blocks;

- $s_k = \dfrac{Nack\_blocks}{Sent\_blocks}$

    Nack_blocks: number of badly received blocks among those sent with ~~the~~a present MCS;

    Sent_blocks: number of blocks sent with ~~the~~a present MCS in ~~the~~a previous polling period:

- $f_1(BLER_{k-1})$ is ~~said~~the first weight function, taking values inside ~~the~~an interval 0 - 1; and

- $f_2(s_k)$ is ~~said~~the second weight function of the variable s_k relative to the decision on the errored blocks, taking values inside the interval 0 - 1.

20. (Currently Amended) The ~~Method~~method ~~for dynamically optimizing data throughput~~ according to claim 19, ~~characterized in that~~wherein ~~said~~the first and second weight functions ~~assume~~comprise the following expressions:

$$f_1(BLER_{k-1}) = (1 - \frac{\beta}{R_k}) \cdot BLER_{k-1}$$

$$f_2(s_k) = \frac{\beta}{R_k} \cdot s_k$$

where~~in~~:

- $\beta = 1/T_{AVG}$ is a forgetting factor and T_{AVG} being ~~the~~a filtering period in multiples of a radio block; and

- $R_k = (1-\beta)^m \cdot R_{k-1} + \beta; \quad R_{-1} = 0$ is said reliability function.

21. (Currently Amended) The ~~Method~~method ~~for dynamically optimizing data throughput~~ according to claim 19, ~~characterized in that said~~wherein the temporary

connection is dedicated to transfer packet data from the base station to a selected mobile station, and ~~said~~ the pulse response of ~~IR_status~~ the status variable digital filter is obtained ~~by means of~~ according to the following function:

$$IR\_status_k = f_1(IR\_status_{k-1}) + f_2(IR\_check_k)$$

where~~in~~:

* k is ~~the~~ a reporting instant lasting m blocks;
* f_1 and f_2 are weight functions following the same laws as used in the ~~BLER~~ Block Error Rate calculation.

22. (Currently Amended) ~~Method~~ The method ~~for dynamically optimizing data throughput~~ according to claim 21, ~~characterized in that said~~ wherein the first and second weight functions ~~assume~~ comprise the following expressions:

$$f_1(IR\_status_{k-1}) = (1 - \frac{\beta}{R_k}) \cdot IR\_check_{k-1}$$

$$f_2(IR\_check_k) = \frac{\beta}{R_k} \cdot IR\_check_k$$

where~~in~~: R_k takes a formal expression as that used in the ~~BLER~~ Block Error Rate calculation, and β is the same.

23. (Currently Amended) The ~~Method~~ method ~~for dynamically optimizing data throughput~~ according to claim 1, ~~characterized in that~~ wherein a modified power control works in parallel with the modulation and coding scheme~~MCS~~ switching link adaptation and the modified power control includes the following steps:

— off-line calculation of the expression:

$$T_{PxTS} = T_P / N_{TS},$$

where~~in~~: T_{PxTS} is ~~the~~ a Peak Throughput per timeslot; T_P is ~~the~~ a Peak Throughput derived from ~~the~~ a Quality of Service Class of the connection, and N_{TS} is ~~the~~ a minimum between ~~the~~ a number of allocable timeslots and ~~the~~ a number of timeslots that can be handled by the mobile station due to its multislot class;

— off-line mapping of the calculated T_{PxTS} on a simulated curve depicting ~~the~~ a maximum achievable net throughput in function of ~~the~~ values of Carrier versus Interference C/I, and obtaining from the curve a target C/I_{target} value; and

– exploiting the C/I_{target} for all ~~the~~ duration of the ongoing connection as a goal to be maintained by the network ~~(BSC, BTS)~~ exploiting the Power and Interference measures at ~~the~~ a receiver side.